

SPACE SHUTTLE UPGRADES

COMPONENT/ELEMENT SAFETY IMPROVEMENT

VEHICLE SAFETY IMPROVEMENT

TOTAL SHUTTLE UPGRADES

SHUTTLE UPGRADES - PHASE I

SSME BLOCK I
PHASE II + POWERHEAD RETROFIT
ALTERNATE TURBOPUMP (HPOTP)
SINGLE TUBE HEX
1 in 404 to 1 in 608 (34% risk reduction)

SSME BLOCK IIA
LARGE THROAT MAIN COMBUSTION CHAMBER (LTMCC)
IMPROVED LPOTP WITH SILICON NITRIDE BEARINGS
IMPROVED LPFTP
1 in 608 to 1 in 999 (39% risk reduction)

SSME BLOCK II
ALTERNATE TURBOPUMP (HPFTP)
1 in 999 to 1 in 1283 (22% risk reduction)

SUPER LIGHTWEIGHT TANK (SLWT)
SAFER (EVA ROBOT)
MULTIFUNCTION ELECTRONIC DISPLAY SYSTEM (MEDS)
GPS
Performance upgrade
Not currently modeled in QRAS
Performance upgrade
Not currently modeled in QRAS

PROPOSED SHUTTLE UPGRADES - PHASE II

CHECKOUT AND LAUNCH CONTROL SYSTEM (CLCS)
SRB COMPOSITE NOSE CAP
SRB ALTITUDE SENSOR ASSY
NOZZLE/CASE JOINT J-LEG INSULATION DESIGN
AIR DATA TRANSDUCER ASSY UPGRADE
RADIATOR TAPE - MMOD
RADIATOR ISOLATION - MMOD
MMOD WING LEADING EDGE
WEIGHT REDUCTION IN FORWARD ORBITER
DISPLAY DRIVER UNIT REPLACEMENT
MASS STORAGE UNIT
LONG LIFE ALKALINE FUEL CELL
SES IMAGE GENERATOR ENHANCEMENT
SRB APU
APU FUEL CARBON SEAL REDESIGN
APU FUEL ISOLATION VALVE
APU TURBINE WHEEL
Performance Upgrade
Eliminates nose cap TPS - Criticality 1
Performance Upgrade
High redundancy joint
Performance Upgrade
Not currently modeled in QRAS
Not currently modeled in QRAS
Not currently modeled in QRAS
Performance Upgrade
Performance Upgrade
Performance Upgrade
1 in 6897 to 1 in 10,989 (37% risk reduction)
Performance Upgrade
1 in 12,910 to 1 in 17,024 (24% risk reduction)

SHUTTLE UPGRADES - High Priority Safety

SSME AHMS
ORBITER ELECTRIC APU
ORBITER TPS MORE DURABLE BELLY TILE
1 in 1283 to 1 in 1732 (25% risk reduction)
1 in 804 to 1 in 80,645 (99% risk reduction)
1 in 2198 to 1 in 2907 (24% risk reduction)

OTHER UPGRADES
MAIN LANDING GEAR
SRB ELECTRIC APU
ETC.

ASCENT

1 in 262 to 1 in 335 (22% risk reduction)

1 in 335 to 1 in 438 (24% risk reduction)

1 in 438 to 1 in 483 (9% risk reduction)

Performance upgrade
Not currently modeled in QRAS
Performance upgrade
Not currently modeled in QRAS

Performance Upgrade
Eliminates nose cap TPS - Criticality 1
Performance Upgrade
High redundancy joint
Performance Upgrade
Not currently modeled in QRAS
Not currently modeled in QRAS
Not currently modeled in QRAS
Performance Upgrade
Performance Upgrade
Performance Upgrade
Performance Upgrade
No safety improvement
Performance Upgrade
11% risk reduction (includes data update)

12% risk reduction
Negligible
Negligible

Projected Shuttle ascent risk after incorporating high priority safety upgrades is 1 in 735

MISSION

1 in 170 to 1 in 198 (14% risk reduction)

1 in 198 to 1 in 233 (15% risk reduction)

1 in 233 to 1 in 245 (5% risk reduction)

Performance upgrade
Not currently modeled in QRAS
Performance upgrade
Not currently modeled in QRAS

Performance Upgrade
Eliminates nose cap TPS - Criticality 1
Performance Upgrade
High redundancy joint
Performance Upgrade
Not currently modeled in QRAS
Not currently modeled in QRAS
Not currently modeled in QRAS
Performance Upgrade
Performance Upgrade
Performance Upgrade
Performance Upgrade
< 1% risk reduction
Performance Upgrade
6% risk reduction (includes data update)

6% risk reduction
18% risk reduction
2% risk reduction

Projected Shuttle Mission risk after incorporating high priority safety upgrades is 1 in 370